

April 9, 1929.

L. O. FRENCH

1,708,056

INTERNAL COMBUSTION ENGINE

Filed July 22, 1927

Fig. 1.

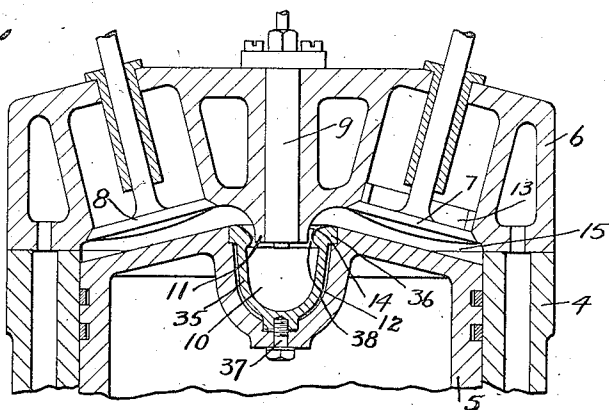


Fig. 2.

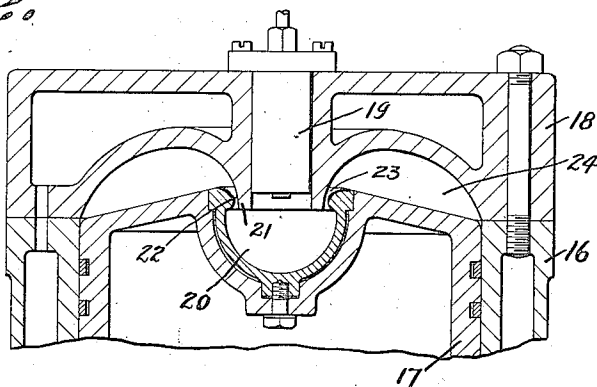
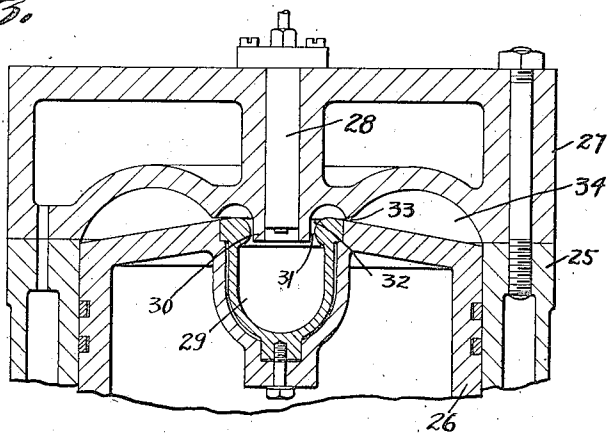


Fig. 3.



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INTERNAL-COMBUSTION ENGINE.

Application filed July 22, 1927. Serial No. 207,771.

The invention relates to internal combustion engines and more particularly to solid fuel injection type engines.

The general object of the invention is to provide a combustion chamber for efficiently mixing and distributing the fuel and fuel mixture to bring about good combustion. More particularly, the invention consists in providing a cavity between a part of the piston and head into which the whole or a part of the fuel is introduced during the compression stroke and which cavity is then in restricted communication with the remainder of the combustion chamber into which the fuel issues through an annular passage of gradually increasing capacity in the direction of flow toward the walls of the cylinder. This cavity is preferably formed in the piston and the head is provided with a projection which enters said cavity near the end of the compression stroke, and the walls of the piston and head are formed to give good distribution of the gases issuing from said cavity which acts as a vaporizer without the disadvantages of permanent restriction or difficulty of scavenging and permitting of efficient operation at high speeds.

A further object of this invention is to provide an improved method of operating high speed internal combustion engines of the general type above described.

The invention further consists in the several features hereinafter set forth and more particularly defined by claims at the conclusion hereof.

In the drawings, Fig. 1 is a detail vertical sectional view through an engine embodying the invention having valves in the head;

Fig. 2 is a similar view, more particularly of a port-scavenging two cycle engine;

Fig. 3 is a view similar to Fig. 2, showing certain modifications.

Referring to Fig. 1, the numeral 4 designates the cylinder, 5 the piston working therein, 6 the cylinder head, 7 the inlet valve, 8 the exhaust valve and 9 a fuel injector of any suitable construction. The injector 9 is arranged centrally in the head in line with a cavity 10 in the top of the piston and near the end of the up stroke a projection 11 on said head enters said cavity and forms a restricted passage 12 between it and the mouth of the cavity. To create a turbulent effect the inlet valve 7 may have a semi-cylinder deflector 13,

of known construction, to direct the air tangentially of the cylinder wall on its entrance.

Beyond the passage 12 the head and piston are curved to provide a flaring passage 14 of gradually increasing capacity in the direction of flow toward the outer space 15.

Referring to Fig. 2, the numeral 16 designates the cylinder, 17 the piston working therein, 18 the cylinder head and 19 the fuel injector. The injector 19 is arranged centrally in the head in line with a cavity 20 in the top of the piston and near the end of the up stroke a projection 21 on said head enters said cavity and forms a restricted passage 22 between it and the mouth of the cavity. Beyond the passage 22 the head and piston are shaped to provide a flaring passage 23 of gradually increasing capacity in the direction of flow toward the outer space 24.

The restriction may be formed by the nozzle itself or a part of the head casting or a part secured thereto and by the term "projection on the head" I mean to include any of these constructions, though where the projection is formed independent of the nozzle the nozzle may terminate above the lower end of said projection, as shown in Fig. 2.

In each of the constructions above described the parts preferably come into restricted relationship when the piston is within about forty-five degrees or less from upper dead center, depending upon the speed of the engine, the greater angle being used for high speed engines so that some or all of the fuel will be discharged by the nozzle into said cavity, though for high speed engines it is preferred to use a nozzle with a wide spreading jet or jets so that some of the fuel strikes the curved mouth of the cavity and does not enter the cavity itself. The fuel injection is started slightly before or during the time the parts move into restricted communication and is continued during the remainder of the compression stroke and as the piston starts down, the so-called mixed combustion cycle (partly constant pressure and partly constant volume) being preferred. As the atomized fuel encounters the heated air in the cavity it is vaporized or gasified and due to the restriction builds up a greater pressure than in the outer space 15 or 24, with the result that this gaseous mixture is expelled through the flaring passage 14 or 23 into said outer space as the piston starts on its down stroke to mix

with the air in said outer space. Thus the pressure of combustion in a temporarily restricted portion of the main combustion chamber is used to expel the fuel charge into the remainder of said chamber through a passage of gradually increasing capacity in the direction of flow and since during the restricted relation of the parts either the air entering the chamber or the gases issuing therefrom flows through the passage 14 or 23 at considerable velocity any fuel temporarily deposited on the piston at the mouth of the cavity will be carried along in the air or gas stream.

The construction shown in Fig. 3 is generally similar to that of Fig. 2 except that I have here provided a restriction beyond the flaring passage so that the pressure is increased after the gases make the turn toward the outer space. In this figure the numeral 25 designates the cylinder, 26 the piston working therein, 27 the cylinder head and 28 the fuel injector.

The injector 28 is arranged centrally in the head in line with a cavity 29 in the top of the piston and near the end of the up stroke a projection 30 on said head enters said cavity and forms a restricted passage 31 between it and the mouth of the cavity. Beyond the restriction the head and piston are shaped to provide a flaring passage 32, a restricted passage 33, and an outer space 34, the passage 33 being most restricted at the upper dead center position and thus causing an increase in pressure in the passage 32 to cause an increase in velocity of the gases as they issue into the outer space 34. This last-described arrangement is particularly effective to produce progressive combustion where some of the fuel is directed against the mouth of the cavity. In all the forms the volume of the cavity is preferably less than that of the outer space and the differential pressure of the gases is utilized to project the fuel into the outer space.

In each instance it is preferred to form the outer walls of the cavity in the piston by means of a cup 35 which has a flanged portion 36 seated in a recess in the piston and a boss at its lower end to receive a clamping screw 37 extending through a centrally located boss in the piston head and to maintain said cup in a heated condition a clearance space 38 may be provided between the outer wall of said cup and the adjacent wall of the piston head proper.

With the above construction, since that portion of the combustion chamber forming the cavity is only temporarily restricted, the cavity may be readily scavenged and will be filled with fresh air during each compression stroke and injection may be commenced considerably in advance of upper dead center in high speed engines and only a part of the fuel be subjected to the throttling effect during the injection period so that the fuel will be

efficiently distributed throughout the combustion-supporting air as the piston starts on its power stroke.

It will be noted that in each instance the walls of the head curve outwardly adjacent the projection to reduce the turbulence of the gas or air streams in making the turn from axial to radial so as to decrease the energy losses and thus allow the gases to efficiently penetrate the outer space of the combustion chamber.

Ignition may be by heat of compression, by the auxiliary ignition devices during starting where heat of compression is insufficient to start from cold, or by spark ignition in case of volatile fuels.

I desire it to be understood that this invention is not to be limited to any particular form or arrangement of parts except in so far as such limitations are specified in the claims.

What I claim as my invention is:

1. In an internal combustion engine, the combination of a cylinder, a cylinder head and a piston working in the cylinder, said piston having a cavity formed in its top, said cylinder head having a projection adapted to enter said cavity near the end of the compression stroke and restricting the flow from said cavity to the space surrounding said cavity, the volume of said cavity being less than the volume of the surrounding clearance space, said piston and head having curved walls leading from the mouth of said cavity and providing a temporary passage of gradually increasing capacity in the direction of flow toward the walls of the cylinder, and means for injecting fuel into said cavity.

2. The method of operating high speed injection type internal combustion engines wherein the piston and head cooperate near the end of the compression stroke to form a cavity in restricted communication with the remainder of the combustion chamber which consists in spraying fuel into the region surrounding the mouth of the cavity before the restriction takes place and thereafter spraying fuel into the cavity as the piston nears or starts on its power stroke.

3. In an internal combustion engine, the combination of a cylinder, a piston working therein and a cylinder head, said piston having a cavity formed in its top, said cylinder head having a projection adapted to enter said cavity near the end of the compression stroke and restricting the flow from said space to the remainder of said combustion space, said piston and head having walls shaped to provide an annular passage to direct the gases from axial to radial flow, and a restriction beyond the turning point of said gases as the piston nears the end of its compression stroke.

In testimony whereof, I affix my signature.

LOUIS O. FRENCH.